LINERLESS METALLIC CAP CLOSURE AND METHOD OF FABRICATING THE SAME

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to closures or caps used in containers designed to store and transport liquids in general and, more specifically, to a linerless metallic cap.

BACKGROUND OF THE ART

[0002] Bottles of many different shapes, sizes, and materials have been widely used for containing and transporting different types of liquids, including those for human consumption, such as, beer, soft drinks, water, juices, coolers, and milk, as well as liquids used for other purposes such as cleaners, raw materials used in different industrial processes, and the like. In most of these applications, a plastic or metallic cap, or top, is provided for adequately sealing the contents of the bottle in order to prevent leakage to the outside as well as contamination by outside seepage of foreign substances. Traditional caps are composed of a plastic or metallic shell and an interior liner designed to maintain the pressure and liquid contents inside the container. These liners are typically made of a single or plurality of layers of the same or different materials, such as cork, rubber, latex, polyvinyl chloride (PVC), and non-PVC compounds, provided between the inner face of the cap and the upper surface of the bottle neck rim. The time-consuming and expensive procedure of applying a liner to the interior of a cap has been significantly reduced by the introduction of linerless plastic caps, but to date, linerless metallic caps had not been developed.

[0003] Usually, during the manufacturing process of a metallic cap, different layers of ink are first deposited on one surface of a metal plate in order to create logos and promotional messages followed by application of a clear protective varnish coating and subsequent curing in a continuous oven. Printing can also be done on the other side of the metallic surface for promotional campaigns or games. Cap shells are then produced

in a punching process, after which, liners are applied to the interior of the shells before they can be applied to close the bottles. The application of the liner material is typically expensive and time consuming because they are usually applied separate from printing and forming or stamping processes, thus increasing labor costs and reducing yield.

[0004] There have been several patents issued for linerless plastic caps, including, for example: (*i*) U.S. Patent Nos. 5,158,195, 4,925,617, 4,872,304, 4,708,255, and 4,770,309 (all assigned to Tri-Tech International Inc.); (*ii*) U.S. Patent No. 3,948,405 (assigned to VCA Corporation); and (*ii*) U.S. Patent No. 4,741,447 (assigned to the American National Can Company). All of these patents use various types of sealing protuberances projecting from the inner surface of the plastic bottle cap. These projections, extending from the top and/or the skirt of the bottle cap, act as a sealing ring or rings having different cross sectional design and are disposed in different arrangements.

[0005] There are many reasons why one would prefer a metallic cap over one made of plastic. The fabrication of plastic caps usually involves expensive and complicated injection molding machinery, particularly in the case of linerless plastic caps. There are also special bottle neck construction requirements for applications using plastic caps. In addition, because of the injection molding fabrication process, plastic caps are much more difficult to imprint with the brand or producer logos, promotional messages, and the like, besides the fact that the imprint finish achieved with metallic surfaces is much more attractive. Also, consumer preference may dictate the use of a metallic crown cap, particular when dealing with traditional drinks and premium presentations, such as, for example, beer.

[0006] Although metallic crown caps of different types, sizes, shapes, and corrugation designs do exist; all of them require a liner in order to function properly. Therefore, a need exists for a new linerless metallic cap that will maintain the known functionality afforded by metallic caps, such as the ability to print logos and promotional messages thereon, and, at the same time, reduce the time consuming and expensive procedure to manufacture and apply the liners, thus reducing labor cost and increasing production yield.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention relates to a metallic linerless closure for liquid containers and methods of fabricating the same, such linerless metallic closures being capable of, among other advantages, eliminating the need, expense, and additional manufacturing time associated with the use of liners.

[0008] A linerless metallic closure in accordance with a feature of the invention comprises a metal closure shell having a top portion and an annular side wall, and a foamed material layer deposited over an inside surface of the top portion of the shell such that application of the linerless closure to a container hermetically seals it by a contact between a portion of the foamed material layer on the top portion and the container's rim.

[0009] A method for manufacturing a linerless metallic closure in accordance with another feature of the invention comprises: providing a metallic sheet having a top surface and a bottom surface; applying a foaming material layer to one of the surfaces of the metallic sheet, and forming the closure from the metallic sheet. The method also comprises applying and curing a coat of varnish, imprinting the metallic sheet with at least one of a brand name, a producer logo, and a promotional message, and curing said ink before said applying a foaming material layer. In accordance with yet another feature of the invention, a method for manufacturing a linerless metallic closure comprises providing a metallic sheet, forming at least one closure shell from the metallic sheet, the closure shell having a top portion and an annular side wall, and applying a foaming material layer to an inner surface of the top portion. In addition, in accordance with yet another feature of the invention, a method for manufacturing a linerless metallic closure comprises providing a roll-on metallic closure shell having a top portion and an annular side wall, and applying a foaming material layer to the inner surfaces of the top portion and the annular side wall. Additionally, in accordance with yet another feature of the invention, a method for manufacturing a linerless metallic closure comprises providing a roll-on metallic enclosure shell having a top portion in an annular side wall, and applying a foaming material layer to the inner surface of the top portion.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0010] In order to facilitate the understanding of the present invention, the description of the invention disclosed herein will be provided with reference to the specific embodiments illustrated in the appended drawings or figures, wherein like structures are identified with like reference designations. The invention will be described and explained with additional specificity and detail by the use of the accompanying drawings, wherein:

FIG. 1 illustrates a side view of a conventional crown cap;

FIG. 2 illustrates a side view of a first embodiment of the present invention, comprising a steel crown shell having a primer interior coating and a foamed material layer completely covering the interior surface of the crown;

FIG. 3 illustrates a side view of a second embodiment of the present invention, comprising a steel or crown shell having a primer interior coating and a foamed material layer partially covering the interior surface of the crown;

FIG. 4 illustrates a side view of a conventional roll-on cap;

FIG. 5 illustrates a side view of a third embodiment of the present invention, comprising a roll-on cap having a primer interior coating and a foamed material layer completely covering the interior surface of the cap; and

FIG. 6 illustrates a side view of a fourth embodiment of the present invention, comprising a roll-on cap having a primer interior coating and foamed material layer partially covering the interior surface of the cap.

DETAILED DESCRIPTION OF THE INVENTION

[0011] FIG. 1 illustrates a known metallic crown cap, or top, 10 comprising a metallic element 11 having a top portion 12, an under portion 14, and a corrugated skirt 16 with

a plurality of skirt undulations 18. Hereinafter, the terms "crown cap," "top," "cap," "crown top," or "closure" are used interchangeably as synonymous terms. Before labels and/or text is imprinted on the cap, a layer of a primer material 22 is applied to the the interior surface 14 of the metallic element 11, on top of which a subsequent liner 24 is also applied. The general process after imprinting brand names or other indicia is to form the cap shell in punching presses. Then the liner, whatever its composition might be, is applied in the interior of the crown shell. In some cases a cure operation is necessary to get the correct adhesion of the liner to the crown shell.

[0012] In use, the metallic crown cap 10 is installed with its under portion 14 on the upper surface of a glass or plastic bottle neck rim (not shown) with the liner 24 firmly kept against the neck rim, preventing leakage of the liquid content as well as other gases, including carbon dioxide used for carbonation. The liner 24 is typically made of different materials such as cork, rubber, latex, PVC, and non-PVC compounds. Once consumption is desired, the metallic crown cap 10 is simply pried off with an opener. Other crown caps are designed to allow their removal by twisting the crown cap off the bottle.

[0013] FIG. 2 illustrates a first embodiment of the linerless crown cap 30 of the present invention. Preferably, the metallic material for the cap includes, for example, tin-free steel, electrolytic-tin plate, and aluminum; although the manufacturing process is different for aluminum caps. Before punching the metallic element 11 in the shape of a crown cap, one or several layers of printing ink (not shown) are deposited on the upper surface 12 in order to differentiate one crown design from another mainly with the logo of the beverage producer, the logo of the beverage brand, or promotional messages. In order to increase production, it is normal to start the manufacturing process with a metal sheet from which a large amount of caps is made. The application of the ink layers is typically made through one or several lithographic processes such as offset, etc. Once applied, the ink imprints are cured in a continuous oven, or furnace, at temperatures ranging from about 150 to about 180 °C, and more preferably between about 160 and about 165 °C. The residence time of the linerless crown caps in the curing oven is varied between about 7 and about 15 minutes, and more preferably between about 8 and

about 9 minutes. It is also possible to imprint these labels and logos, or any other promotional messages, on the under portion 14 of the linerless crown cap 30.

[0014] A clear protective varnish coating may also be applied over the ink imprints of the top surface to prevent scratches and damages of that surface and also to allow the mobility of the crown in the chutes of the bottling lines. Preferred examples of applying this protective varnish coating include any of the following methods: with application rollers onto flat metal sheet during a lithographic process, electro deposition (coil coating), or spray application technology. Once applied, the protective coating may also be cured in a continuous oven at a temperatures ranging from approximately 160 to 210 °C, and more preferably between about 177 and about 183 °C. The residence time of the imprinted metal sheets in the curing oven to cure the protective varnish coating may vary from about 7 to about 15 minutes, and more preferably between about 8 and about 9 minutes. In addition, depending on the materials used for coating or imprinting the linerless crown cap 30, an Ultra Violet (UV) light source may also be used for curing purposes.

[0015] In addition, a protective layer of organosol, and/or primer material, 22 may also be applied to the under portion 14 of the linerless crown cap 30. The main purpose of the organosol layer is to enhance adhesion to the interior surface of the cap for any kind of liner or subsequent layers deposited thereon. Of course it also helps in providing corrosion resistance to steel caps. Primer materials also enhance adhesion to the cap of the materials (mainly inks) that will be applied in the subsequent steps. The nature of the primers depends on the material to be adhered, e.g., for PVC-based materials, the primers are vinyl type, and for printing inks, the primers may be polyesters, epoxies, or alquidalic. Once applied, the primer layer 22 may also be cured in a continuous oven at a temperatures ranging from about 160 to about 210 °C, and more preferably between about 197 and about 203 °C. This curing time may vary from about 7 to approximately 15 minutes, and more preferably between about 8 and about 9 minutes.

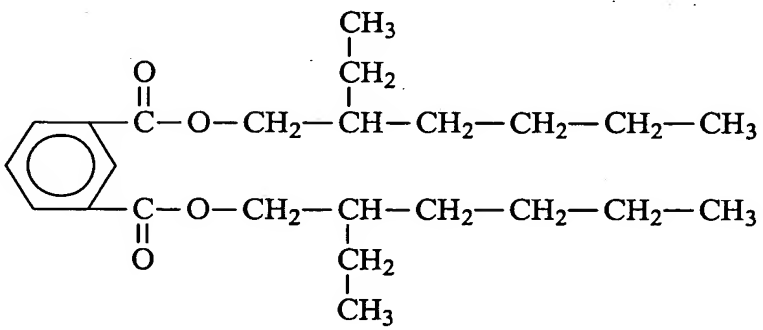
[0016] As illustrated in FIG. 2, once the layer of primer material 22 has been applied, an additional coating of a foamed material layer 32 is applied before the forming operation to assure that the bottle container will be sealed once the linerless crown cap

30 is properly installed thereto. In another feature of the invention, the foamed material 32 may be applied after the forming of the cap. This foamed material layer 32 on the under portion 14 of the linerless crown cap 30 assumes the functionality of a liner regarding the preservation of the content, the carbonic gas, and all of the other desired liner design performances, including, for example, a secure seal test, torque removal requirements, etc. The foamed material layer 32 will also be able to accommodate disparities usually found during the manufacturing process, including, for example, imperfections on the bottle neck sealing surface and wide variations in bottle neck dimensional tolerances. In a preferred embodiment of the invention, the foamed material layer 32 can comprise a stack of relatively thin portions or sub layers.

[0017] As will be understood by those of ordinary skill in the art, some of the advantages of this invention include, for example: (*i*) the fact that a liner is not required for the closure functionality; (*ii*) significant savings, including, for example, labor, equipment, spare parts, maintenance, energy, and others, as a result of the omission of at least an extrusion operation during the manufacturing process; (*iii*) a wide range of applicability as to the type of bottle, even recycled ones having worn-off defects; (*iv*) a simplified and expedited manufacturing process; and (*v*) applicability to a wide range of neck diameters and bottle finishes resulting in a very flexible closure available for a wide market.

[0018] This foamed material layer 32 is composed of a foamed compound having the ability to foam during curing. The composition formulation of the foamed material layer 32 may be based on a mixture of vinyl resins with some additives and foaming agents. The foamed material layer 32 may also be made as a combination of three different types of materials, including a resin, a plasticizer, and a blowing agent. The temperature range for the curing process of the foamed material layer 32 is from about 180 to about 220 °C, and more preferably between about 192 and about 198 °C. The curing time for the foamed material layer 32 varies from about 1.5 to about 5 minutes, and more preferably between approximately 2 and 2.5 minutes. In addition, the thickness of the foamed material layer 32 varies from about 0.25 mm (0.010 inches) to approximately 0.50 mm (0.020 inches). The preferred thickness of the foamed material layer 32 is about 38 mm (0.015 inches).

[0019] An example of a resin to be used in the foamed material mixture of the present invention is a polyvinyl chloride (PVC) on concentrations ranging from about 40 to about 50% by weight, more preferably approximately 45%. A preferred method of application of the foamed material mixture is by use of rollers commonly used in the lithographic industry. Exemplary plasticizers include a di-octil phthalate (DOP) or a di-isodecyl phthalate (DIP), both having a concentration varying between about 50 and about 55% by weight, more preferably 52.5%. Mixtures of both of these plasticizers, at similar concentration levels, are also possible. A preferred DOP plasticizer has the following chemical formula:



[0020] In addition, examples of blowing agents to be used in making the foamed material layer 32 include azodicarbonamide (ADC), modified azodicarbonamide (MADC), dinitrosopentametilentetramine (DNPT), benzensulfonil hidracide (BSH), 4,4 oxibisbenzene sulfonyl hidrazide (OBSH), toluensulfonyl semicarbazide (TSSC), 5-penyltrazole, derived hydrazide, and sodium bicarbonate (SBC). The preferred concentrations of blowing agents used in making the foamed material layer 32 varies from about 1 to about 5% by weight, and more preferably about 2.5%. In addition, the preferred blowing agent compound is sodium bicarbonate, or SBC. Finally, the reaction of the compound during foaming while the metallic crown cap 30 is being cured may be represented by the following global chemical reaction:

$$2NaHCO_3 + 2C_6H_5\,COOH \rightarrow 2C_6H_5COONa + H_2O + 2CO_2\,.$$

[0021] There are at least two alternative ways for the application of the material to form the foamed material layer 32 on the linerless crown cap 30. In the first method, the

material is first applied to the metallic sheet before the metallic crown caps are punched out. A linerless crown cap 30 made using this method is illustrated in FIG. 2 after the metallic sheet has been punched to form the crown cap. As illustrated, the foamed material layer 32 is formed over the entire surface area of the under portion 14 of the liner crown cap 30, including the corrugated skirt 16 and the skirt undulations 18. This first method is attractive because it at least eliminates the need for a separate working station for the application of the foamed material layer 32, thus reducing capital cost and increasing production.

[0022] The application of the foamed material layer 32 can also be done after punching the crown caps. FIG. 3 illustrates another embodiment of a linerless crown cap 30 having the foamed material layer 32 applied after punching of the crown cap. In this case, the amount of foamed material used is reduced because the corrugated skirt 16 and associated skirt undulations 18 are not covered. Nevertheless, sufficient coverage of the under portion 14 is accomplished to assure that the linerless crown cap 30 will perform its designed sealing function.

[0023] The present invention is also applicable to roll-on caps. FIG. 4 illustrates a side view of a conventional roll-on cap 40, comprising a metallic element 41 having a top portion 12, an under portion 14, and inwardly projection cap threads 42. Similar to the illustration of FIG. 1, a convention roll-on cap may also have a layer of a primer material 22 applied to the interior surface 14 of the metallic element 41, on top of which a subsequent liner 24 is also applied. FIG. 5 illustrates a third embodiment of the invention related to a linerless roll-on cap 50. The preferred material for these roll-on caps is aluminum. As shown, similar to the disposition of layers in FIG. 2, a clear protective varnish coating (not shown) and a protective layer of primer material 22 is applied to the under portion 14 of the linerless roll-on cap 50. In addition, a foamed material layer 32 is applied to the entire surface area of the under portion 14 of the linerless roll-on cap 50. The same materials for the different layers, compositions, temperature ranges, and residence curing times disclosed for the linerless crown cap 30 are applicable to the linerless roll-on cap 50. Similar to the embodiment of FIG. 3, as illustrated in FIG. 6, it is also possible to apply the foamed material compound 32 only to a fraction of the under portion 14 of the linerless roll-on cap 50.

[0024] The method of manufacturing linerless caps or closures is also within the scope of the present invention. In this regard, the details presented hereinabove in conjunction with the apparatus disclosure, including materials, compositions, manufacturing conditions, etc, are also applicable to the method of manufacturer and will not be repeated. Initially, metallic sheets, preferably tin-free steel or electrolytic-tin plate, are provided with at least one overcoat of varnish applied thereto and properly cured. A protective layer of organosol is then applied to facilitate movement of the caps throughout the manufacturing process. Once the coating with organosol and varnish are completed and cured, transfer ink is applied over the varnish and cured. Afterward, a layer of foamed material is applied to the inside portion of the metallic plate.

[0025] Once the application of the foamed material is finished, the metal sheets are then punched to form closure shells in order to manufacture the linerless crown caps. It is also possible to first punch the crown shells from the metallic plate before the application of the foamed material. In this case, there would be a significant savings of foamed material for the layer because it would only be applied to the inner surface of the top section of the shell and not to the entire shell undersurface including the skirt thereof. Linerless roll-on caps, made preferably out of aluminum, may also be manufactured according to a feature of the present invention. In this case, the aluminum roll-on cap shell is first formed using known processes and then the foamed material is applied either to the entire inner surface of shell or to a fraction thereof.

[0026] Although typical embodiments and details have been explained herein above with the intention of illustrating several best modes of the present invention as applied to linerless crown or roll-on caps, and the like, it is understood that several changes and variations in the methods, apparatuses, and systems disclosed herein may be implemented within the scope of the present invention. The scope of the invention being appropriately determined by the claims appended below.